

What is claimed is:

1. A medical device for removing gas from a liquid to be delivered to a patient, the device comprising:

a housing defining a chamber including a liquid inlet and a liquid outlet;

a gas filter structure disposed within the chamber, the filter structure comprising a first gas permeable membrane layer spaced from a second gas permeable membrane layer, the first and second layers defining a gas collection space between the first and second layers, and defining a liquid flow space separated from the gas collection space by at least one of the membrane layers; and

a gas outlet in fluid communication with the gas collection space.

2. The device of claim 1, wherein the first and second membrane layers are coiled, curved, or folded within the housing.

3. The device of claim 1, wherein the first and second membrane layers are coiled about a longitudinal axis within the housing.

4. The device of claim 1, wherein the first and second membrane layers are folded within the housing.

5. The device of claim 1, wherein the first and second membrane layers each include an inner surface defining at least a portion of the gas collection space and an outer surface defining at least a portion of the liquid flow space.

6. The device of claim 5, wherein the first and second membrane layers are coiled, curved, or folded within the housing such that at least a portion of the liquid flow space is defined between outer surfaces of the membrane layers.

7. The device of claim 1, further including a conduit extending within the housing, the conduit connecting and in fluid communication with the gas collection space and the gas outlet.

8. The device of claim 7, wherein the conduit comprises a tubular member extending within the housing, the tubular member defining a lumen that provides fluid communication between the gas collection space and the gas outlet.

9. The device of claim 8, wherein at least a portion of the tubular member extends along a longitudinal axis within the housing, and the first and second membrane layers are coiled about the tubular member along at least a portion of the longitudinal axis.

10. The device of claim 8, wherein the tubular member includes a wall defining the lumen, and one or more opening in the wall, and wherein the first gas permeable membrane layer is connected to the wall along a first side of the opening and the second gas permeable membrane layer is connected to the wall along a second side of the opening so as to provide fluid communication between the gas collection space and the lumen.

11. The device of claim 1, wherein the gas outlet comprises a gas outlet port defined in the housing.

12. The device of claim 11, wherein the gas outlet port defines one or more opening in the housing, and wherein the first gas permeable membrane layer is connected to the housing along a first side of the opening and the second gas permeable membrane layer is connected to the housing along a second side of the opening so as to provide fluid communication between the gas collection space and the gas outlet port.

13. The device of claim 1, further including a conduit extending through at least a portion of the chamber within the housing, the conduit extending from adjacent the liquid inlet to adjacent the liquid outlet, and being configured to receive an elongated medical device.

14. The device of claim 13, wherein the conduit comprises a tubular member extending within the chamber within the housing, the tubular member defining a lumen configured for receiving or passing an elongated medical device there through.

15. The device of claim 13, wherein the conduit extends to a medical device delivery port in the housing.

16. The device of claim 1, further including a conduit extending through at least a portion of the chamber within the housing, the conduit extending from a medical device delivery port in the housing to adjacent the liquid outlet, and being configured to receive an elongated medical device.

17. The device of claim 1, further including:  
a first conduit extending within the housing, the conduit extending between and in fluid communication with the gas collection space and the gas outlet; and  
a second conduit extending within the housing, the second conduit extending from adjacent the liquid inlet to adjacent the liquid outlet, and being configured to receive an elongated medical device.

18. The device of claim 17, wherein the first and second conduits are coaxially disposed along at least a portion of the lengths thereof.

19. The device of claim 1, wherein the filter structure further includes a gas permeable spacer layer disposed within the gas collection space.

20. The device of claim 1, wherein the filter structure further includes a liquid permeable spacer layer disposed within the liquid flow space.

21. The device of claim 1, the device further including:

a first liquid path conduit within the chamber and in fluid communication with the liquid inlet and the liquid outlet, the gas filter structure being disposed within the first liquid path conduit;

a second liquid path conduit within the chamber and in fluid communication with the liquid inlet and the liquid outlet;

a valve assembly configured to allow for the flow of liquid from the liquid inlet to the liquid outlet through the first liquid path conduit while preventing the flow of liquid from the liquid inlet to the liquid outlet through the second liquid path conduit, and the valve assembly further configured to allow for the flow of liquid from the liquid outlet to the liquid inlet through the second liquid path conduit while preventing the flow of liquid from the liquid outlet to the liquid inlet through the first liquid path conduit.

22. The device of claim 21, wherein the a valve assembly includes:

a first one way check valve disposed within the first liquid path conduit and allowing one-directional liquid flow from the liquid inlet to the liquid outlet through the first liquid path conduit; and

a second one way check valve disposed within the second liquid path conduit and allowing one-directional liquid flow from the liquid outlet to the liquid inlet through the second liquid path conduit.

23. The device of claim 1, wherein the device further includes a vacuum creating structure attached to the housing and fluid communication with the gas outlet.

24. The device of claim 23, wherein the vacuum creating structure includes a structure mounted onto the housing and defining a lumen in fluid communication with the gas outlet, and a plunger member disposed within the lumen.

25. A medical device for removing gas from a liquid to be delivered to a patient, the device comprising:

- a housing defining a chamber including a liquid inlet and a liquid outlet;

- a filter structure disposed within the chamber, the filter structure comprising: a first gas permeable membrane layer including an inner surface and an outer surface; a gas permeable spacer layer; a second gas permeable membrane layer including an inner surface and an outer surface; and a liquid permeable spacer layer; the first and second membrane layers being connected and defining an inner gas collection space between the inner surfaces of the first and second membrane layers, and defining a liquid flow space separated from the gas collection space by at least one of the membrane layers; the gas permeable spacer layer being disposed within the gas collection space, and the liquid permeable spacer layer being disposed within the liquid flow space; and

- a gas outlet in fluid communication with the gas collection space.

26. The device of claim 25, wherein the housing and filter structure are configured such that when the liquid is introduced through the inlet port into the chamber at least some of the liquid contacts the liquid contact surface such that at least a portion of gasses present in the liquid permeate through one of the membrane layers and into the gas collection space.

27. A medical device for removing gas from a liquid to be delivered to a patient, the device comprising:

- a housing defining a chamber including a liquid inlet and a liquid outlet;

- a filter structure disposed within the chamber, the filter structure comprising a first gas permeable membrane layer spaced apart from a second gas permeable membrane layer, both layers including an inner surface, an outer surface, and an outer periphery, the

first and second layers connected to each other along at least a portion of the outer peripheries and defining a gas collection space between the inner surfaces of the first and second layers, and defining a liquid flow space along at least a portion of the outer surface of one or both of the first and second layers; and

a gas outlet port in fluid communication with the gas collection space.

28. A medical fluid delivery system for use in delivering a liquid to a patient, the system comprising:

a fluid delivery manifold including a manifold body defining a fluid delivery lumen, the manifold including one or more liquid inlet ports and one or more liquid outlet ports in selective fluid communication with the fluid delivery lumen; and

a device for removing gas from the liquid, the device being configured to be connected to at least one of the ports of the manifold, the device including a housing defining a chamber including a liquid inlet and a liquid outlet; a gas filter structure disposed within the chamber, the filter structure comprising a first gas permeable membrane layer spaced from a second gas permeable membrane layer, the first and second layers defining a gas collection space between the first and second layers, and defining a liquid flow space separated from the gas collection space by at least one of the membrane layers; and a gas outlet in fluid communication with the gas collection space.

29. A method for removing gasses from a liquid to be delivered to a patient, the method comprising:

providing a medical device for removing gas from the liquid, the device comprising:

a housing defining a chamber including a liquid inlet and a liquid outlet;

a gas filter structure disposed within the chamber, the filter structure comprising a first gas permeable membrane layer spaced from a second gas permeable membrane layer, the first and second layers defining a gas collection space between the first and second layers, and defining a liquid flow space

separated from the gas collection space by at least one of the membrane layers;  
and

a gas outlet in fluid communication with the gas collection space;

introducing liquid into the chamber through the liquid inlet such that the liquid flows into the liquid flow space; and

moving the liquid from within the liquid flow space and through the liquid outlet.

30. The method of claim 29, wherein the first and second membrane layers are coiled, curved, or folded within the housing.

31. The method of claim 29, wherein the first and second membrane layers are coiled about a longitudinal axis within the housing.

32. The method of claim 29, wherein the first and second membrane layers are folded within the housing.

33. The method of claim 29, wherein the first and second membrane layers each include an inner surface defining at least a portion of the gas collection space and an outer surface defining at least a portion of the liquid flow space.

34. The method of claim 33, wherein the first and second membrane layers are coiled, curved, or folded within the housing such that at least a portion of the liquid flow space is defined between outer surfaces of the membrane layers.

35. The method of claim 29, wherein the device further includes a conduit extending within the housing, the conduit extending between and in fluid communication with the gas collection space and the gas outlet.

36. The method of claim 35, wherein the conduit comprises a tubular member extending within the housing, the tubular member defining a lumen that provides fluid communication between the gas collection space and the gas outlet.

37. The method of claim 36, wherein at least a portion of the tubular member extends along a longitudinal axis within the housing, and the first and second membrane layers are coiled about the tubular member along at least a portion of the longitudinal axis.

38. The method of claim 36, wherein the tubular member includes a wall defining the lumen, and one or more opening in the wall, and wherein the first gas permeable membrane layer is connected to the wall along a first side of the opening and the second gas permeable membrane layer is connected to the wall along a second side of the opening so as to provide fluid communication between the gas collection space and the lumen.

39. The method of claim 1, wherein the gas outlet comprises a gas outlet port defined in the housing.

40. The method of claim 39, wherein the gas outlet port defines one or more opening in the housing, and wherein the first gas permeable membrane layer is connected to the housing along a first side of the opening and the second gas permeable membrane layer is connected to the housing along a second side of the opening so as to provide fluid communication between the gas collection space and the gas outlet port.

41. The method of claim 29, wherein the device further includes a conduit extending through at least a portion of the chamber within the housing, the conduit extending from adjacent the liquid inlet to adjacent the liquid outlet, and being configured to receive an elongated medical device.



42. The method of claim 41, wherein the conduit comprises a tubular member extending within the chamber within the housing, the tubular member defining a lumen configured for receiving or passing an elongated medical device there through.

43. The method of claim 41, wherein the conduit extends to a medical device delivery port in the housing.

44. The method of claim 29, wherein the device further includes a conduit extending through at least a portion of the chamber within the housing, the conduit extending from a medical device delivery port in the housing to adjacent the liquid outlet, and being configured to receive an elongated medical device.

45. The method of claim 29, wherein the device further includes:  
a first conduit extending within the housing, the conduit extending between and in fluid communication with the gas collection space and the gas outlet; and  
a second conduit extending within the housing, the second conduit extending from adjacent the liquid inlet to adjacent the liquid outlet, and being configured to receive an elongated medical device.

46. The method of claim 45, wherein the first and second conduits are coaxially disposed along at least a portion of the lengths thereof.

47. The method of claim 29, wherein the filter structure further includes a gas permeable spacer layer disposed within the gas collection space.

48. The method of claim 29, wherein the filter structure further includes a liquid permeable spacer layer disposed within the liquid flow space.

49. The method of claim 29, wherein the device further includes:

a first liquid path conduit within the chamber and in fluid communication with the liquid inlet and the liquid outlet, the gas filter structure being disposed within the first liquid path conduit;

a second liquid path conduit within the chamber and in fluid communication with the liquid inlet and the liquid outlet;

a valve assembly configured to allow for the flow of liquid from the liquid inlet to the liquid outlet through the first liquid path conduit while preventing the flow of liquid from the liquid inlet to the liquid outlet through the second liquid path conduit, and the valve assembly further configured to allow for the flow of liquid from the liquid outlet to the liquid inlet through the second liquid path conduit while preventing the flow of liquid from the liquid outlet to the liquid inlet through the first liquid path conduit.

50. The method of claim 49, wherein the valve assembly includes:

a first one way check valve disposed within the first liquid path conduit and allowing one-directional liquid flow from the liquid inlet to the liquid outlet through the first liquid path conduit; and

a second one way check valve disposed within the second liquid path conduit and allowing one-directional liquid flow from the liquid outlet to the liquid inlet through the second liquid path conduit.

51. The method of claim 29, wherein the device further includes a vacuum creating structure attached to the housing and fluid communication with the gas outlet.

52. The method of claim 51, wherein the vacuum creating structure includes a structure mounted onto the housing and defining a lumen in fluid communication with the gas outlet, and a plunger member disposed within the lumen.

53. A manifold for use in delivering a liquid to a patient, the manifold comprising:

a manifold body defining a fluid delivery lumen, the manifold including one or more liquid inlet ports and one or more liquid outlet ports, the manifold body also including a gas filter structure disposed within the fluid delivery lumen, the gas filter structure comprising:

a first gas permeable membrane layer and a second gas permeable membrane layer, the first and second layers forming a gas collection space between the first and second layers, and defining a liquid flow space separated from the gas collection space by at least one of the membrane layers; and

a gas outlet in fluid communication with the gas collection space.

54. A manifold for use in delivering a liquid to a patient, the manifold comprising:

a manifold body defining a fluid delivery lumen having an inner surface, the manifold including one or more liquid inlet ports and one or more liquid outlet ports, the manifold body also including a gas filter structure disposed within the fluid delivery lumen, the gas filter structure comprising:

a plurality of hollow tubular members made of a gas permeable membrane material disposed within the lumen, each of the tubular members having a first end and a second end;

a first liquid tight seal between the first end of each of the tubular members and the interior surface of the lumen;

a second liquid tight seal between the second end of each of the tubular members and the interior surface of the lumen, wherein a gas collection space is defined by the first and second liquid tight seals; and

a gas outlet in fluid communication with the gas collection space.

55. A medical device for removing gas from a liquid to be delivered to a patient, the device comprising:

a housing defining a chamber defining an inner surface and including a liquid inlet and a liquid outlet;

a gas filter structure disposed within the chamber, the filter structure comprising:

a plurality of hollow tubular members made of a gas permeable membrane material disposed within the lumen, each of the tubular members having a first end and a second end;

a first liquid tight seal between the first end of each of the tubular members and the interior surface of the chamber;

a second liquid tight seal between the second end of each of the tubular members and the interior surface of the chamber, wherein a gas collection space is defined by the first and second liquid tight seals;

a gas outlet port extending through the housing; and

a conduit extending within the housing, the conduit connecting and in fluid communication with the gas collection space and the gas outlet.

56. The device of claim 55, wherein the conduit comprises a tubular member extending within the housing, the tubular member defining a lumen that provides fluid communication between the gas collection space and the gas outlet.

57. The device of claim 55, wherein at least a portion of the tubular member extends along a longitudinal axis within the housing and within the gas collection space.

58. The device of claim 55, further including a second conduit extending within the housing, the second conduit extending from adjacent the liquid inlet to adjacent the liquid outlet, and being configured to receive an elongated medical device.

59. The device of claim 58, wherein the conduit and the second conduit are coaxially disposed along at least a portion of the lengths thereof.

60. A medical device for removing gas from a liquid to be delivered to a patient, the device comprising:

a housing defining a chamber defining an inner surface and including a liquid inlet and a liquid outlet;

a gas filter structure disposed within the chamber, the filter structure comprising:

a plurality of hollow tubular members made of a gas permeable membrane material disposed within the lumen, each of the tubular members having a first end and a second end;

a first liquid tight seal between the first end of each of the tubular members and the interior surface of the chamber; and

a second liquid tight seal between the second end of each of the tubular members and the interior surface of the chamber, wherein a gas collection space is defined by the first and second liquid tight seals;

a gas outlet in fluid communication with the gas collection space; and

a vacuum creating structure attached to the housing and fluid communication with the gas outlet.

61. The device of claim 60, wherein the vacuum creating structure includes a structure mounted onto the housing and defining a lumen in fluid communication with the gas outlet, and a plunger member disposed within the lumen.

62. A medical device for removing gas from a liquid to be delivered to a patient, the device comprising:

a housing defining a chamber defining an inner surface and including a liquid inlet and a liquid outlet;

a first liquid path conduit within the chamber and in fluid communication with the liquid inlet and the liquid outlet, the first liquid path conduit defining a lumen having an inner surface;

a second liquid path conduit within the chamber and in fluid communication with the liquid inlet and the liquid outlet;

a valve assembly configured to allow for the flow of liquid from the liquid inlet to the liquid outlet through the first liquid path conduit while preventing the flow of liquid

from the liquid inlet to the liquid outlet through the second liquid path conduit, and the valve assembly further configured to allow for the flow of liquid from the liquid outlet to the liquid inlet through the second liquid path conduit while preventing the flow of liquid from the liquid outlet to the liquid inlet through the first liquid path conduit; and

a gas filter structure disposed within the first liquid path conduit, the filter structure comprising:

a plurality of hollow tubular members made of a gas permeable membrane material disposed within the lumen, each of the tubular members having a first end and a second end;

a first liquid tight seal between the first end of each of the tubular members and the inner surface of the lumen;

a second liquid tight seal between the second end of each of the tubular members and the inner surface of the lumen, wherein a gas collection space is defined by the first and second liquid tight seals; and

a gas outlet in fluid communication with the gas collection space.

63. The device of claim 62, wherein the valve assembly includes:

a first one way check valve disposed within the first liquid path conduit and allowing one-directional liquid flow from the liquid inlet to the liquid outlet through the first liquid path conduit; and

a second one way check valve disposed within the second liquid path conduit and allowing one-directional liquid flow from the liquid outlet to the liquid inlet through the second liquid path conduit.